

Recommended by The Ministry of
Education of Republic of Kazakhstan

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BIOLOGY

Grade 10

1ST EDITION

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PREFACE

Natural science is an exciting and very useful subject. This textbook will show you all the beauty of it and will help you become true explorers. The main aim of this book is to answer the fundamental question: “What is science and what is its importance in our life?”


Starting from the first pages, you will realize that this textbook is completely different from any other usual textbook full of theoretical passages. Every chapter contains useful information, interesting facts, tasks for individual and group work. You will also learn how to conduct researches and experiments yourselves, search for information, make your own discoveries.

One more valuable feature of this textbook is the language. Every sentence has been carefully chosen so that it is not difficult for you to understand science in English language. Each page contains the translation of all the important terms, both in Kazakh and Russian. This textbook will not only help you improve your English, but it will also make you a part of a big international science community.

Please pay attention to the structure of this textbook. Remember: a textbook is no longer the only source of information in a modern world. With the help of carefully selected tasks, you are going to learn such important skills as critical thinking, problem solving, information analysis, creativity, imagination, teamwork, digital literacy etc.

If you have any questions, suggestions or ideas regarding the contents of this book, please feel free to contact us:

- via email:

 info@astanakitap.kz

Best regards,
team of authors, “Astana-kitap”

HOW TO USE THIS BOOK

Lesson opener question

Chapter title

Lesson objectives

1.1

WATER

Definitions of main terms

You will

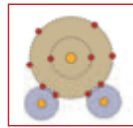
Why do scientists look for water in other places in the solar system?

- explain the fundamental importance of water for life on Earth.

Water is the most abundant component of life. It is an inorganic compound consisting of two hydrogen atoms and one oxygen atom linked by two covalent bonds. Water is a polar molecule, it's charged positively near the hydrogen atoms and negatively near the oxygen atom. The negative ends of water molecules attract the positive ends of other water molecules forming hydrogen bonds.

Key terms

Cohesion - the sticking together of particles of the same substance;
Specific heat capacity - the amount of heat per unit mass required to raise the temperature by one degree Celsius;
Solvent - able to dissolve other substances.



Water's polarity is caused by its V-shape.

The polarity of water molecules and hydrogen bonding between them give water unique properties which makes it vital to life.

Water is a good solvent. Many substances have molecules with any charged groups. When these substances are added to the solution oxygen attracts positive ions while hydrogen attracts negative ions. Charged particles become dispersed among the water molecules and easily dissolve. Water transports substances as a solution around organisms by transport systems. Metabolic reactions between substances take place in water solutions.

Hydrogen bonds give water molecules cohesive properties. Cohesion is the attraction between water molecules. Adhesion is the attraction of water molecules to a surface. These properties allow water and minerals move upwards through vascular tissue of plants.

Main text

Facts ?

Water is the only substance found pure in all three states of matter on the Earth.



Pond skaters supported by the force of the surface tension

Activity **Dehydration of organic compounds.**

1. Create a mind map for water properties and compare with your partner.
2. What would happen if water has a different property? Discuss with your partner and fill the table.

If water	Consequences	Affected organisms
is a nonpolar molecule		
has extremely low specific heat capacity		
is less dense than ice		
has lower amount of heat to vaporise		

Interesting facts

Activities to do during the lesson by students

Questions to review the chapter

Experiment of the chapter

Q Labwork

Pre-lab questions:

1. What is the monomer of starch?
2. What is the function of amylase?
3. Does glucose molecule have aldehyde or ketone group?

Methods and Materials: table sugar, starch, water, saliva, three test tubes, water bath, Benedict's solution, droppers, tweezers.

Safety precautions:

1. Be careful with boiling water

Procedures:

1. Mix starch with water to make a starch solution and place 1 ml of it into the first and second test tubes.
2. Add saliva into the first test tube. Wait for 5 minutes.
3. Mix table sugar with water to make sucrose solution.
4. Place 1 ml of sucrose solution into the third test tube and 1 ml of water into the fourth test tube.
5. Pour 10 drops of Benedict's solution to every sample.
6. Place all test tubes into the water bath for 10 minutes.
7. Observe color change in each sample and fill the table.

Test samples	Carbohydrates	Color	Reducing or Nonreducing sugars	Chemical structure
1st test tube				
2nd test tube				
3rd test tube				
4th test tube				

Post-lab questions:

1. Why the first test and second test tubes have different colors? Explain your answer.
2. Benedict's test can be used to test for the presence of glucose in urine. Why it is needed?

Literacy

1. Which substances cannot dissolve in water and why? Explain your answer.
2. Why ice is less dense than water?
3. Annual change in temperature in cities located near the oceans or seas is much lower than in cities located far from oceans and seas. Explain this phenomenon?

Terminology

abundant - моль / обильный;	solvent - ериткіш / растворитель;
consequence - салдар / последствие;	specific heat capacity - меншікті жылу сыйымдылығы / удельная теплоемкость
dispersed - таралган / рассеянный;	surface tension - беттік керіліс / поверхностное натяжение;
dissolved - еріген / растворенный;	transparency - мөңдірлік / прозрачность.
essential - қажетті / необходимый;	
lattice - тор / решетка;	
motion - қозғалыс / движение;	
resistant - төзімділік / стойкий;	

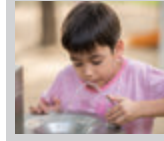
Experiment of the chapter



Water takes the high amount of heat to vaporize

Facts

Water covers three-quarter of the Earth's surface, but unfortunately, only about 0.3% is usable by humans.



Research time

Another important property of water is its transparency. Research and find out its significance for plants and animals. Write a report about it.



Research related to the lesson

New terms of the chapter

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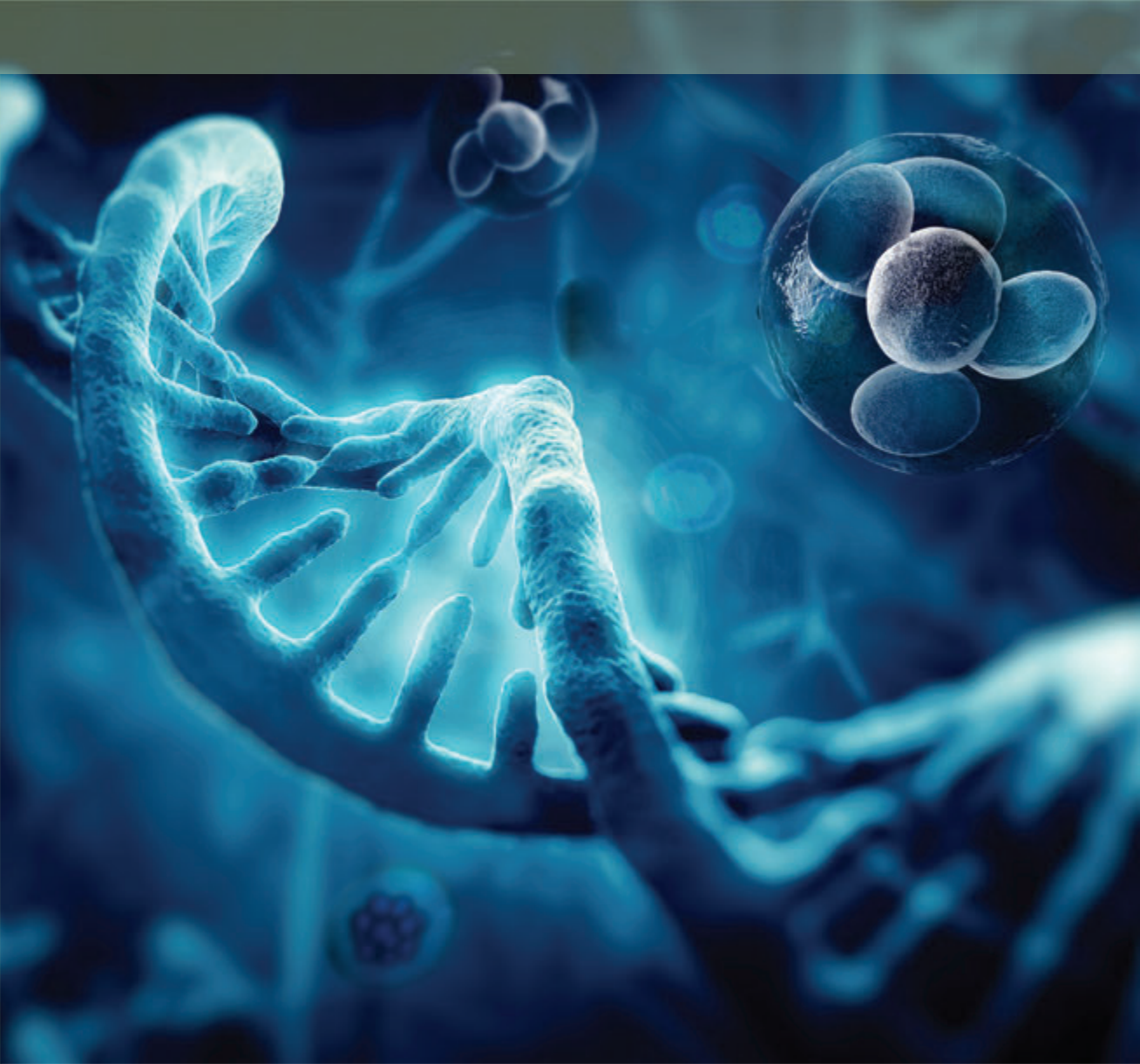
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1

CHAPTER

MOLECULAR BIOLOGY AND BIOCHEMISTRY

1. Water
2. Simple carbohydrates
3. Polysaccharides
4. Reducing and Nonreducing sugars
5. Lipids
6. Lipid Classification
7. Protein
8. Protein Function
9. Protein Denaturation
10. Protein Determination
11. DNA
12. DNA Replication
13. RNA
14. Nucleic acids





You will

- explain the fundamental importance of water for life on Earth.



Key terms

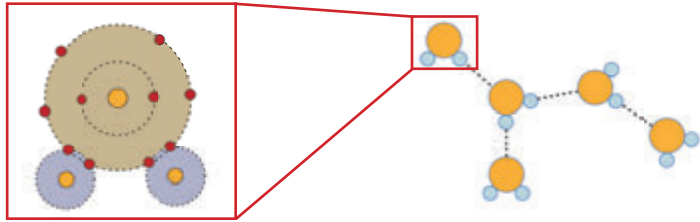
Cohesion - the sticking together of particles of the same substance;

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Why do scientists look for water in other places in the solar system?

Water is the most abundant component of life. It is an inorganic compound consisting of two hydrogen atoms and one oxygen atom linked by two covalent bonds. Water is a polar molecule, it's charged partially positively near the hydrogen atoms and partially negatively near the oxygen atom. The negative ends of water molecules attract the positive ends of other water molecules forming hydrogen bonds.



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Hydrogen bonds give water molecules cohesive properties. Cohesion is the attraction between water molecules. Adhesion is the attraction of water molecules to a surface. These properties allow water and minerals move upwards through vascular tissue of plants.

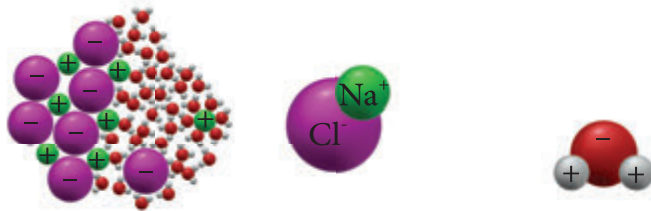
A consequence of cohesion is high surface tension, a measure of the difficulty of breaking the surface of a liquid. Water molecules at the surface are exposed to air on one side, and have less water molecules to bond than in deeper within the liquid. They cause water molecules to have stronger bonds at the surface forming an invisible "membrane". Small insects take advantage of surface tension by walking on water.

Facts ?

Water is the only substance found pure in all three states of matter on the Earth.



Pond skaters supported by the force of the surface tension



NaCl is dissolving in water

Another property of water is related to its high specific heat capacity. A specific heat capacity of water is the amount of heat that causes 1g of water to change its temperature by 1°C. A large amount of energy is

required to raise the temperature of water. When water is heated, some energy added by heating is used to break hydrogen bonds instead of causing more motion among the molecules. The abundant hydrogen bonds make water resistant to temperature changes. This stability is essential for biochemical reactions and for aquatic organisms. It helps maintain a body temperature of mammals and moderates Earth's climate change.



Hydrogen bonds form a lattice structure in ice.

Most liquids increase in density and decrease in volume when become solid. However, water has a lower density as a solid than a liquid. This freezing property allows ice to float on water and lakes freeze at the top protecting organisms below.

Activity *Dehydration of organic compounds.*

1. Create a mind map for water properties and compare with your partner.
2. What would happen if water has a different property? Discuss with your partner and fill the table.

<i>If water</i>	<i>Consequences</i>	<i>Affected organisms</i>
is a nonpolar molecule		
has extremely low specific heat capacity		
is less dense than ice		
has lower amount of heat to vaporise		

Literacy

1. Which substances cannot dissolve in water and why? Explain your answer.
2. Why ice is less dense than water?
3. Annual change in temperature in cities located near the oceans or seas is much lower than in cities located far from oceans and seas. Explain this phenomenon?

Terminology

abundant - мол / обильный;
 consequence - салдар /
 последствие;
 dispersed - таралған /
 рассеянный;
 dissolved - еріген / растворенный;
 essential - қажетті /
 необходимый;
 lattice - тор / решетка;
 motion - қозғалыс / движение;

resistant - төзімділік / стойкий;
 solvent - еріткіш / растворитель;
 specific heat capacity - меншікті
 жылу сыйымдылығы / удельная
 теплоемкость;
 surface tension - беттік керіліс /
 поверхностное натяжение;
 transparency - мөлдірлік /
 прозрачность.



Water takes the high amount of heat to vaporize

Facts

Water covers three-quarter of the Earth's surface, but unfortunately, only about 0.3% is usable by humans.



Research time

Another important property of water is its transparency. Research and find out its significance for plants and animals. Write a report about it.





You will

- classify carbohydrates by their structure, composition and functions.

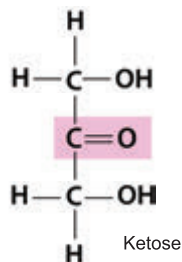
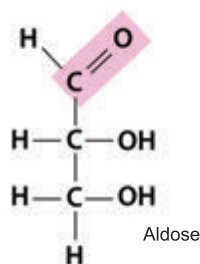


Key terms

Carbohydrates - biological molecules made of carbon, hydrogen, and oxygen atoms;

Monosaccharide - a simple sugar, the basic unit of carbohydrates;

Disaccharide - a double sugar composed of two linked molecules of monosaccharides.



Triose sugars

Where did the carbohydrates get their name from?

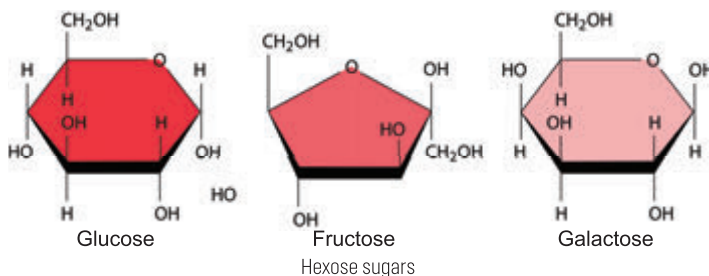
Carbohydrates are organic compounds consisting of carbon (C), oxygen (O), and hydrogen (H) atoms. Their general formula is $C_n(H_2O)_n$, where n can be equal or more than 3. Carbohydrates are classified into three groups: monosaccharides, disaccharides and polysaccharides.

Monosaccharides

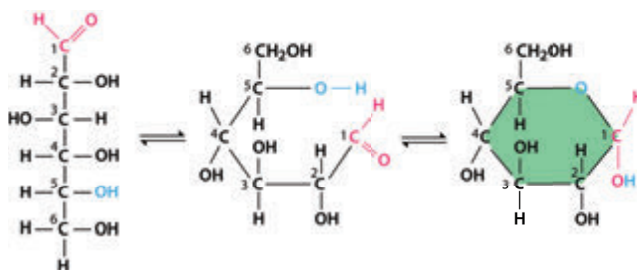
Monosaccharides are simple sugars that usually have three to seven carbon atoms. They can join to make more complex carbohydrates. Their structure contains a carbonyl group (CO) and multiple hydroxyl groups (-OH). According to the position of carbonyl group, they are classified as aldose or ketose. Aldoses' carbonyl group is located at the end of the carbon skeleton while ketoses' carbonyl group is located within a carbon skeleton.

Monosaccharides also can be named according to their number of carbons: some of the most common types are trioses (three C), pentoses (five C), and hexoses (six C). Pentose sugars include deoxyribose and ribose. They are important components of nucleic acids.

Three of the most important hexoses are glucose, fructose, and galactose. They have the same chemical composition ($C_6H_{12}O_6$) but have different characteristics according to the different arrangement of atoms. Such materials are called isomers. Isomers, in general, have different physical properties based on their structure.



Glucose is one of the most common monosaccharide used by nearly every form of life. It provides both energy and structure to many organisms. Glucose molecules can be precursors for the cellular respiration to produce energy in the form of ATP. If energy is not needed it bonds with other monosaccharides and stored in the organism.



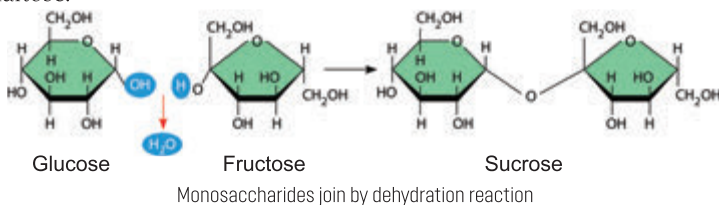
Pentose and hexose sugars form rings in aqueous solutions

Fructose has slightly different arrangement of atoms than glucose. It can be produced in organisms from glucose. Fructose is the source of energy, it enhances the absorption of water, sodium, and potassium. Main source of fructose is fruits and honey.

Galactose is produced in many organisms, but mainly in mammals. Galactose is the component of milk; it is used as an energy source by the offspring.

Disaccharides

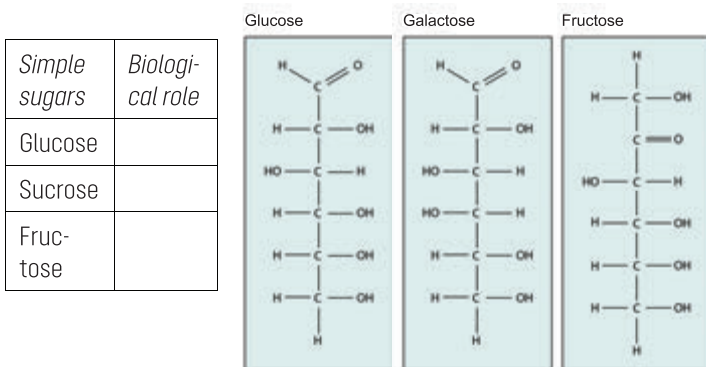
Disaccharides are crystalline, water-soluble sugars, consisting of two monosaccharides. They are joined by glycosidic bond (linkage). When two monosaccharide molecules react to form a glycosidic linkage, a water molecule is generated in the process through a chemical reaction known as dehydration (condensation). The inverse reaction is called hydrolysis. During hydrolysis water is added to break down glycosidic linkages. The three common disaccharides are sucrose, lactose and maltose.



Sucrose comes from joining of fructose and glucose. Sucrose is the main component of table sugar. Lactose comes from glucose and galactose joining. It is found in mammal's milk. Maltose is a product of starch breakdown during digestion that consists of two molecules of glucose. It may be purified from barley and other grains.

Activity

1. Label the differences between hexose sugars.
2. Draw the breakdown of lactose and maltose in the chemical reaction.
3. Describe a biological role of the following carbohydrates.



Simple sugars	Biological role
Glucose	
Sucrose	
Fructose	

Literacy

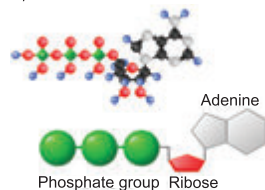
1. Why carbohydrates are considered as organic molecules?
2. During which process carbohydrates are produced?
3. Describe the processes of dehydration and hydrolysis reactions.

Facts

Lactose intolerance is an inability to digest and absorb lactose, found in dairy products. It occurs when the small intestine does not make enough lactase enzyme. Symptoms are gases, belly pain, and bloating.

Research time

Find information about pentose sugars. Explain their biological role, and draw their cyclic chemical structures.



Terminology

arrangement - орналасу / расположение;
barley - арпа / ячмень;
dehydration reaction - дегидратация реакциясы / реакция дегидратации;
glycosidic bond - гликозидтік байланыс / гликозидная связь;
hydrolysis reaction - гидролиз реакциясы / реакция гидролиза;
precursor - ізашар, алғызат / предшественник;
property - қасиет / свойство;
provide - қамтамасыз ету / обеспечивать;
to compose - құрастыру / составить;
to enhance - күшейту / усиливать;
to generate - шығару / производить;
to join - біріктіру / соединять;
to locate - орналастыру / размещать.



You will

- classify carbohydrates by their structure, composition and functions.



Key terms

Polysaccharide - a large molecule composed of a long chains of monosaccharide units bound together by glycosidic linkage.

Glycosidic linkage - is a type of covalent bond, formed between monosaccharides.

What happens to excess glucose in different organisms?

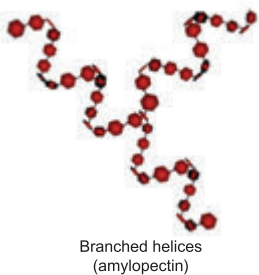
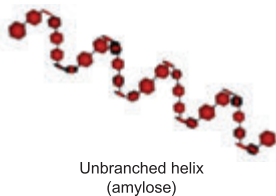
Polysaccharides are complex carbohydrates. They consist of a long chain of monosaccharides linked together by a glycosidic bond. Polysaccharide chain may be branched or unbranched. Their main functions are storage of energy and structural composition of the cell. The major examples of polysaccharides are starch, glycogen, cellulose, and chitin.

Starch is the storage polysaccharide found in plants. It consists of glucose monomers. During photosynthesis, an excess amount of glucose is joined together and is stored in plant organs in the form of starch. Starch has two forms: amylose and amylopectin. Amylose is the linear form of starch where glucose molecules joined by 1-4 linkage (first carbon of glucose joins to fourth carbon of another glucose). It can form a helical structure. This structure of amylose allows cells to store energy in a compact form and makes it easily accessible. Amylopectin is the branched form of starch where glucose molecules joined by 1-6 linkages in branching points. Branching occurs about every 20 glucose units.

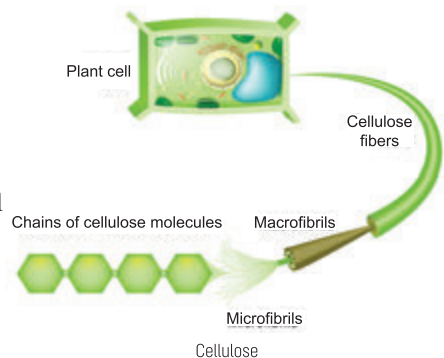
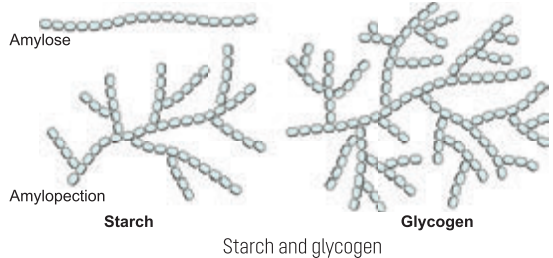
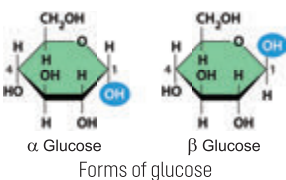
Human, animals, bacteria and fungi store energy in a different form of polysaccharide called glycogen. It is a polymer of glucose, and it is similar to amylopectin but it has larger number of branches. These branches are shorter than those in amylopectin. Branching occurs in every 10 glucose units. Glycogen is generally stored in liver and muscle cells. When organism requires glucose for energy, glycogen is hydrolysed.

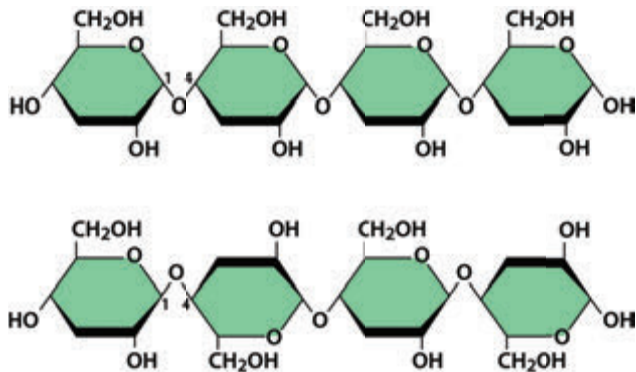
Cellulose is the component of plant cell wall. It has fibrous, linear structure made up of glucose units. Unlike amylose, it has a different glycosidic linkage. When glucose forms cyclic structure, -OH group attached to the first carbon can be either below or above the plane. According to this, glucose is called alpha (α) or beta (β).

In starch, α glucose molecules are located at the same orientation while in cellulose, each β glucose is upside down to the next β glucose. The linear structure of cellulose molecules allows them to bond between -OH groups on closely chains causing a fibre. These bonds give them great mechanical strength.

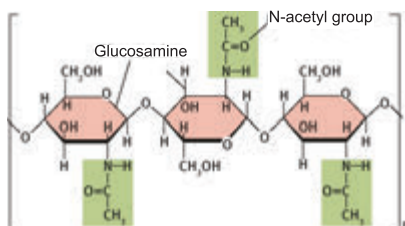


Amylose and amylopectin





Chitin is the structural polysaccharide. It is a component of exoskeleton, found in most arthropods, and cell wall of fungi. Chitin is a polymer of N-glucosamine molecules, derivatives of glucose. These molecules have attached nitrogen-containing group. Like cellulose, monomers of chitin are linked by β -glycosidic bonds.



? Facts

The purest form of cellulose found in nature is cotton. It contains 95% of cellulose.



? Facts

Starch is the most important source of carbohydrates in the human diet. Greater percentage of starch is found in potato 15%, wheat 55%, corn 65%, and rice 75%.



Activity

Fill the table. Some examples are given. Draw the diagram and shape of polysaccharides in first two columns.

Shape	Diagram	Branches	Bonds	Subunit	Source	
				α - glucose	Amylose	
		yes per 10 glucose			Amylopectin	
			1-4 and 1-6		Glycogen	
					Cellulose	
					Chitin	

🔒 Literacy

1. Which polysaccharide is the most abundant in nature?
2. Describe how the structure of cellulose plays an important role in plants as a component of cell walls.
3. Glycogen is composed of short highly branched chains with much accessible glucose. Why is this important for its function?

Research time

Write a report about biological role of each polysaccharide.



🔒 Terminology

accessible - қолжетімді / доступный;
 branched - тармақталған / разветвленный;
 cellulose - жасуық / целлюлоза;
 chitin - хитин;
 fibrous - талшықты / волокнистый;
 glycogen - гликоген;
 helical - шиыршықтанған / спиральный;
 linear - сызықтық / линейный;
 plane - жазықтық / плоскость;
 starch - крахмал.



You will

- identify reducing and nonreducing sugars.



Key terms

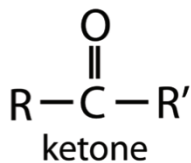
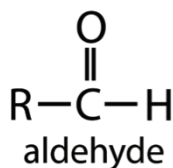
Reducing sugar - sugar that serves as a reducing agent due to its aldehyde or ketone group in its molecular structure;

Nonreducing sugar

- sugar that cannot donate electrons to other molecules and therefore cannot act as a reducing agent;

Reducing agent - reduces other substances and loses electrons;

Oxidizing agent - oxidises other substances and gains electrons.

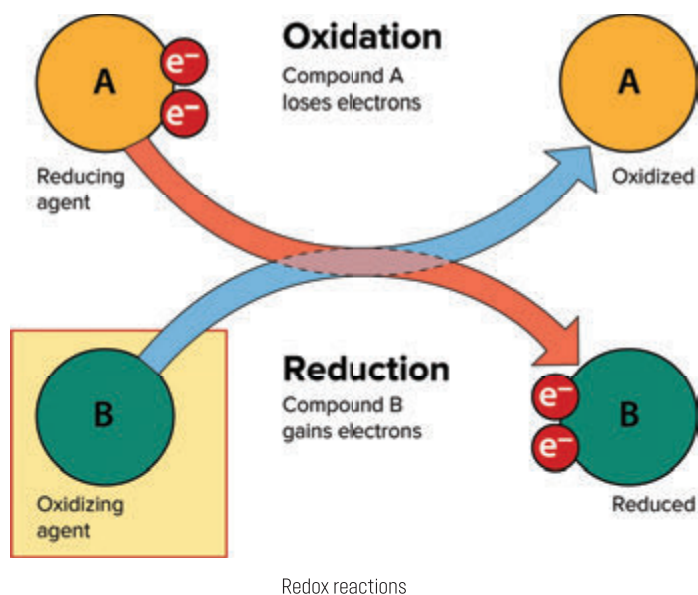


Carbonyl compounds

How do doctors find carbohydrates during urine analysis of patients with diabetes?

Carbohydrates also classified as reducing and nonreducing sugars. Sugar that contains a free aldehyde or ketone group is called reducing sugar.

In reducing sugar, free aldehyde or ketone group acts as a reducing agent in a redox reaction. Redox (oxidation-reduction) reaction is a type of chemical reaction that involves the transfer of electrons between two molecules. Reducing agent donates electrons to another molecule. The molecule which receives electrons is called an oxidising agent.



Nonreducing sugars do not contain free aldehyde or ketone group, and therefore they cannot donate electrons.

Benedict's test is used to identify whether carbohydrate is reducing or nonreducing sugar. It is a chemical reagent which is a complex mixture of sodium carbonate, sodium citrate and copper (II) sulphate pentahydrate. When reducing sugars are mixed with Benedict's solution and heated, heating causes Benedict's solution to change colour because copper (II) ions are reduced to copper (I) ions.

Labwork

Pre-lab questions:

1. What is the monomer of starch?
2. What is the function of amylase?
3. Does glucose molecule have aldehyde or ketone group?

Methods and Materials: table sugar, starch, water, saliva, four test tubes, water bath, Benedict's solution, droppers, tweezers.

Safety precautions:

1. Be careful with boiling water.
2. Do not taste the materials.

Procedures:

1. Mix starch with water to make a starch solution and place 1 ml of it into the first and second test tubes.
2. Add saliva into the first test tube. Wait for 5 minutes.
3. Mix table sugar with water to make sucrose solution.
4. Place 1 ml of sucrose solution into the third test tube and 1ml of water into the fourth test tube.
5. Pour 10 drops of Benedict's solution to every sample.
6. Place all test tubes into the water bath for 10 minutes.
7. Observe color change in each sample and fill the table.

Results:

Test samples	Carbohydrates	Color	Reducing or Nonreducing sugars	Chemical structure
1st test tube				
2nd test tube				
3rd test tube				
4th test tube				

Post-lab questions:

1. Why the first test and second test tubes have different colors? Explain your answer.
2. Benedict's test can be used to test for the presence of glucose in urine. Why it is needed?



Blue solution:
No reducing sugar



Green solution:
Traces of reducing sugar



Orange solution:
Moderate amount of reducing sugar



Brick Red solution:
Large amount of reducing sugar

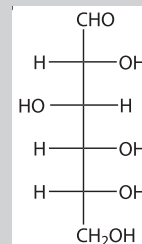
Interpretation of Benedict's test

Research time

Find out three reducing and nonreducing sugars. Draw their chemical structure and prove if they are reducing or nonreducing sugars.

Facts

All monosaccharides are reducing sugars



Terminology

interpretation - түсінік беру / толкование;
 nonreducing sugar - тотықсызданбайтын қант / нередуцирующий сахар;
 oxidation - тотығу / окисление;
 reduction - тотықсыздану / восстановление;
 reducing sugar - тотықсызданатын қант / редуцирующий сахар;
 to donate - беру / давать;
 to oxidize - тотықтыру / окислять;
 to reduce - тотықсыздандыру / восстанавливать.



You will

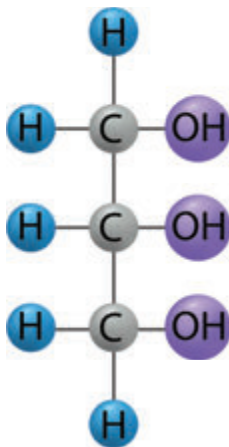
- describe the chemical structure and function of lipids.



Key terms

Lipids - biomolecules that are soluble in organic solvents and insoluble in water;

Triglyceride - an energy-rich compound made up of a single molecule of glycerol and three molecules of fatty acid.



Molecular formula of glycerol is $C_3H_8O_3$



Fats and oils

How can camels survive so long without water?

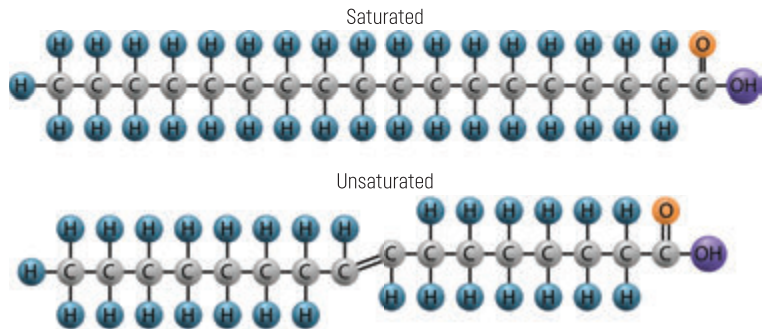
Lipids are organic compounds that consist of carbon, hydrogen and oxygen atoms. Some lipids may contain phosphorus and nitrogen. Unlike carbohydrates, lipid molecules have much lower proportion of oxygen to hydrogen.

Lipids are nonpolar molecules, they cannot be dissolved in water. However, they are soluble in nonpolar solvents, such as alcohol. They are very diverse, and they have variety of structures and functions. The most well-known lipids are fats and oils which referred to triglycerides.

Triglycerides

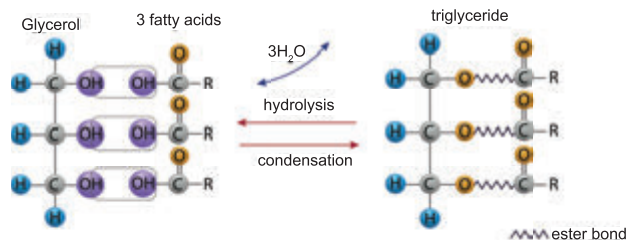
Triglycerides contain glycerol and three fatty acids. Glycerol is a three carbon-containing molecule. It has three polar hydroxyl (-OH) groups, which makes it soluble in water.

Glycerol always has constant structure, while fatty acids have different forms. According to this, triglycerides differ in structure and function. A fatty acid has a long chain of carbon atoms bonded only to hydrogen and carboxyl group at one end. They are classified as saturated and unsaturated fatty acids. Saturated fatty acids have single bonds (C - C) in the hydrocarbon chain, and they are saturated with hydrogen. Unsaturated fatty acids have fewer hydrogen atoms because they have one (monounsaturated) or more (polyunsaturated) double bonds (C = C) in the hydrocarbon chain.



Fatty acids

To form triglyceride, each of hydroxyl (-OH) group in glycerol reacts with carboxyl (-COOH) group of fatty acids. This reaction removes three molecules of water and creates ester bonds between glycerol and fatty acids.



Triglycerides can be formed by condensation and split by hydrolysis.

Fats consist of saturated fatty acids. They are solid at room temperature and produced in animals.

Oils generally have a higher proportion of unsaturated fatty acids. They are liquid at room temperature and mostly found in plants.

Double bonds in fatty acids create a bend in a hydrocarbon chain. These bends prevent close packing of hydrocarbon chains and explain fluidity of oil.

Lipids are used as high energy stores because they are insoluble in water and stable. They can be easily used to release energy.

Fats form insulating layer against heat loss. They conduct heat energy very slowly and help organisms to keep warm in cold climates. In addition, fat under skin protects the internal organs against physical damage and provide buoyancy.

Fat is often deposited near the delicate organs like liver and heart to give extra protection.



Fat helps organisms to keep warm in cold climates.

Activity

1. Make a Venn diagram of fats and oils. Give examples of food products rich in fat.
2. Draw a saturated and an unsaturated fatty acids with six carbons. Count hydrogen numbers in each of them.
3. Draw a simplified diagram of triglyceride. Label glycerol, fatty acids and ester bonds.
4. As the number of double bonds in fatty acids increase, the melting point decreases. If you put a product with high level of unsaturated fats and a product with high level of saturated fats in a refrigerator, how would they differ in consistency? Explain your answer.



Literacy

1. What is the biological importance of triglycerides?
2. Which properties of lipids help them play their biological roles? Explain your answer.
3. How fat layer provides buoyancy?

Terminology

буоянцы - қалқымалылық /
плавучесть;
conduct - өткізу / проводить;
consistency - консистенция;
fatty acid - май қышқылы /
жирная кислота;
glycerol - глицерин;
saturated - қаныққан /

насыщенный;
to create - жасау / создавать;
to dissolve - еру / растворяться;
to insulate - оқшаулау /
изолировать;
triglyceride - триглицерид;
unsaturated - қанықпаған /
ненасыщенный.

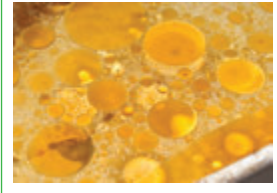
Facts

Lipids release many water molecules when they are metabolized. The camel's hump contains fat which produces useful amount of water.



Research time

1g of lipid can yield over twice as much energy as 1g of carbohydrate and protein. Do a research and explain this statement.



Facts

There are two essential fatty acids, linoleic and linolenic acids, that humans cannot synthesise. They must acquire these fatty acids from food like fish, broccoli, nuts, olive oil, and grain.





You will

- describe the chemical structure and function of lipids.



Key terms

Phospholipid - a lipid containing a phosphate group in its molecule;
Steroid - a type of lipid characterised by carbon skeleton consisting of four fused rings with various chemical groups attached;

Wax - a lipid made up of a chain of alkanes or esters from alcohols and fatty acids.



Many leaves covered with wax to reduce transpiration.

Facts ?

Anabolic steroids are substances similar to testosterone which promote muscle growth. The use of these drugs forbidden in international sports. They cause many health diseases such as liver damage and heart diseases.

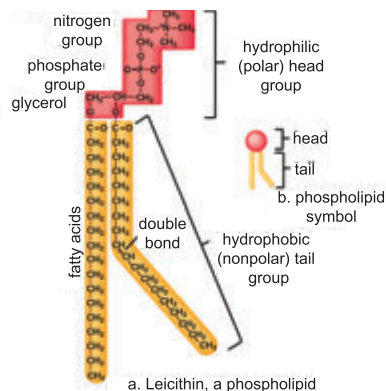


Which substances do bees use to build honeycombs?
 How bees build their honeycombs?

Apart from fats and oils, there are other types of lipids which play an important role in living organisms. They include phospholipids, waxes, and steroids.

Phospholipids

Phospholipids include phosphorus (P) in addition to C, H, and O. They are formed by condensation of glycerol with two fatty acid molecules and phosphoric acid molecule. Phosphoric acid reacts with one of the three hydroxyl groups (-OH) of glycerol while other two hydroxyl groups (-OH) react with fatty acid chains. A phospholipid has two distinct regions: polar head and nonpolar tails. The "phosphoric" part of the molecule has polar hydroxyl groups (-OH) groups which make it hydrophilic (water-loving). Hydrophilic head is attracted to water molecules. Another part of the molecule including two fatty acids is hydrophobic (water-hating). Hydrophobic tails repel water molecules.

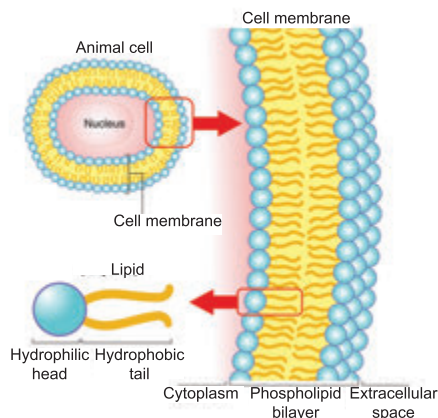


In aqueous solution, phospholipids form spherical structures called micelles. The hydrophobic tails turn inwards and become protected from water by hydrophilic heads. These properties determine the structure and function of the cell membrane. Cell membrane consists of mainly phospholipids bilayer. It forms a boundary between the outside and inside environment of the cell.

Waxes

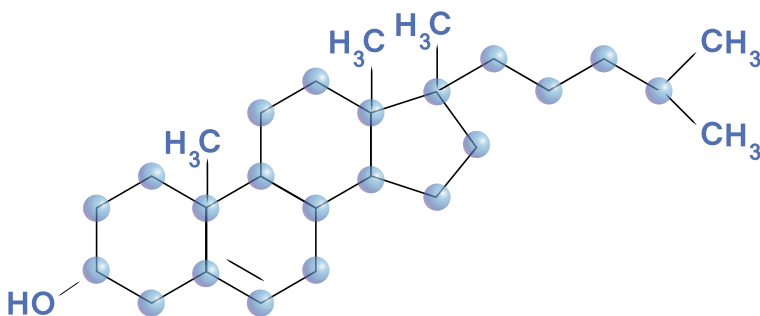
Wax is composed of a single long-chain fatty acid linked to a long-chain alcohol other than glycerol. They are very hydrophobic because of their long nonpolar chains, and animals cannot digest them.

Waxes form waterproof coverings in living organisms. These covers stop water from getting in, and for terrestrial plants and animals, it prevents water loss. For example, feathers of birds are coated with wax to repel the water. Also, insects have a waxy cuticle to prevent water loss.



Steroids

Steroids consist of four interlinked rings of carbon atoms with various side chains. Cholesterol is a well-known steroid. It is produced in the liver as well as being supplied in the diet. It is a vital component of the cell membrane which helps to keep it fluid. All other steroids and vitamin D are synthesised from cholesterol. Some hormones are made up of steroids such as aldosterone, progesterone, and testosterone.



The structure of cholesterol

Activity

Identify the differences between types of lipids. Fill the table.

<i>Lipids</i>	<i>Components</i>	<i>Examples</i>	<i>Functions</i>
Triglycerides			
Phospholipids			
Waxes			
Steroids			

Literacy

1. Why lipids are not considered as polymers?
2. Why triglycerides don't form lipid bilayer?

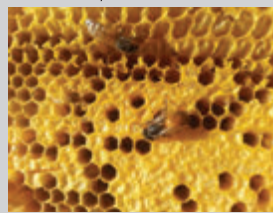
Terminology

ceruminous glands - церуминозды бездері / церуминозные железы
 cuticle - кутикула;
 distinct - айқын / отчетливый;
 forbidden - тыйым салынған / запрещенный;
 honeycomb - кәрез / соты;
 interlinked - өзара байланысқан / взаимосвязанный;
 to consider - қарастыру /

рассматривать;
 to determine - анықтау / определить;
 to promote - мүмкіндік туғызу / способствовать;
 to repel - итеру / отталкивать;
 waterproof - су өтпейтін / водонепроницаемый;
 wax - балауыз / воск.

Facts

Bees have ceruminous glands which secrete wax for building their honeycombs.



Research time

Cholesterol is often related to heart diseases. Do a research and identify its connection. Use words below and write a report.

lipoprotein LDL HDL
 blood flow atherosclerosis
 stroke heart attack diet





You will

- classify proteins according to their composition, structure and functions.



Key terms

Amino acid - a simple organic compound containing both a carboxyl ($-\text{COOH}$) and an amino ($-\text{NH}_2$) group;
Protein - large biomolecules, or macromolecules, consisting of one or more long chains of amino acid residues.

What makes spider silk strong and stretchy?

Protein is the most important polymer, which consists of amino acids. All amino acids contain carbon, hydrogen, oxygen and nitrogen atoms while some may have sulphur atoms too.

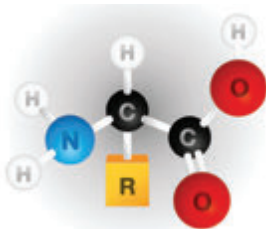
Amino acids have the basic structure which includes a central carbon atom, bonded to an amino group ($-\text{NH}_2$), a carboxyl group ($-\text{COOH}$), and a hydrogen atom. Also, there is another atom or group of atoms linked to central carbon known as radical group (R-group). R-groups differ in amino acids and determine each amino acid.

Amino acids link together by condensation reaction. When two amino acids condense, the amino group of one amino acid links with the carboxyl group of another amino acid forming a dipeptide. The bond which links amino acids is called a peptide bond. Continuous condensation reactions between amino acids create long chains of amino acids called polypeptides. Proteins consist of one or more polypeptides.

Proteins are classified according to their composition, structure and function.

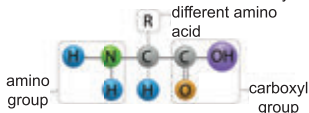
Based on chemical composition, proteins divided into two groups: simple and conjugated proteins. Simple proteins contain only amino acids. Examples are plasma albumin, collagen and keratin. Conjugated proteins include a non-protein portion called as a prosthetic group. The prosthetic group is a compound that helps proteins in different ways. According to the prosthetic group, conjugated proteins subdivided into:

- Glycoproteins contain carbohydrates. Ex: blood plasma proteins (except albumin), immunoglobulin, and antibodies.
 - Lipoproteins contain lipids. They are found in the bloodstream and as a component of the plasma membrane.
 - Phosphoproteins contain a phosphate group. Ex: milk casein and egg white ovalbumin.
 - Chromoproteins contain pigments. Ex: hemoglobin which contains heme, rhodopsin which contains retinal.
- Proteins have four levels of structure.



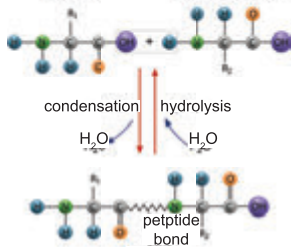
Amino acid

"R" group - different in every different amino acid



Structural formula of amino acid

amino acid 1 amino acid 2

dipeptide
Condensation of amino acids

Primary structure

Primary structure of a protein is the sequence of amino acids in the chain. This sequence determines proteins shape, and shape determines its function. The only bonds involved in this structure are peptide bonds.

Secondary structure

The secondary structure of a protein involves the twisting or folding of polypeptide chains caused by hydrogen bonds. The backbone of polypeptides carries partially positive and negative charges which form hydrogen bonds.

Common types of secondary structure are alpha-helices and beta-pleated sheets.

In the alpha-helix, the CO group of one amino acid is hydrogen bonded to NH group of amino acid further along the chain. These bondings twist

the chain into the spiral shape and help to maintain the shape of the protein.

Beta-pleated sheets formed in anti-parallel polypeptide chains. CO groups of one chain are hydrogen bonded to NH group of parallel chains folding a flat structure of the protein. This shape gives strength to the protein.

Tertiary structure

The tertiary structure of a protein involves the folding and coiling of polypeptide chains into three-dimensional shape. It is formed by various bonds between R-groups of amino acids. Different shapes can be created by different R-groups and by three types of bonds: hydrogen, ionic, and disulphide bonds.

Hydrogen bonds are weakest bonds formed between H and O atoms.

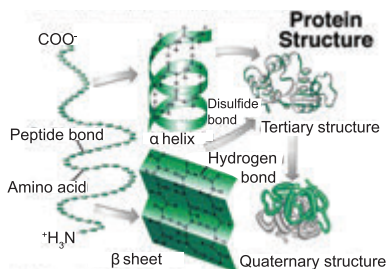
Ionic bonds occur between any charged groups that are not joined by the peptide bond. These bonds are stronger than hydrogen bonds, however weaker than disulphide bonds.

Disulphide bonds form between sulfur atoms found in R-groups.

Also, the shape of protein is affected by hydrophobic R-groups which repel the water.

Quaternary structure

The quaternary structure of a protein involves two or more polypeptide chains linked together. Each polypeptide chain is called a subunit of the protein.



Activity

- There are 20 different amino acids, which make up proteins. Polypeptide chains may be formed with any number and any different order of amino acids. How many different polypeptides would be formed if the chain contains hundred of amino acids?
- Compare each levels of protein structure and fill the table.

Levels	Defini-tion	Simple diagram	Bonds involved	Impor-tance	Examples
Primary structure					
Secondary structure					
Tertiary structure					
Quaternary structure					

Literacy

- What is the reaction by which proteins are formed from amino acids?
- Explain the basis for the great diversity of protein?

Facts

Spider dragline silk has regions of alpha-helix and beta-pleated sheet that make it both elastic and strong.



Research time

A small change in primary structure of protein crucially affects its shape and function. Do a research about sickle cell anemia. Explain its cause and write a report about this disease.

Terminology

alpha-helix - альфа-шиыршық / альфа-спираль;
 amino group - амин тобы / аминная группа;
 beta-pleated sheet - бета-қатпарлы қабат / бета-складчатая форма;
 carboxyl group - карбоксил тобы / карбоксильная группа;
 coiling - бүктелу / свертывание;
 conjugated - күрделі / сложный;
 folding - бүгіліс / сгиб;
 prosthetic group - протетикалық топ / протетическая группа;
 radical group - радикал тобы / радикальная группа;
 to condense - топталу / конденсироваться;
 to subdivide - бөліну / подразделять;
 twist - бұрылыс / поворот;



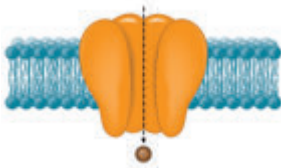
You will

- classify proteins according to their composition, structure and functions.

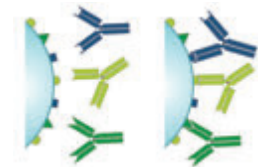


Key terms

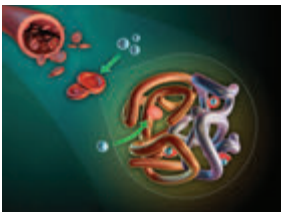
Globular proteins - proteins coiled into compact shapes with hydrophilic outer surface that make them water soluble;
Fibrous proteins - proteins composed of long linear polypeptide chains that are bundled together to form strand or sheets.



Protein channels in cell membrane



Antibodies



Hemoglobin carrying oxygen

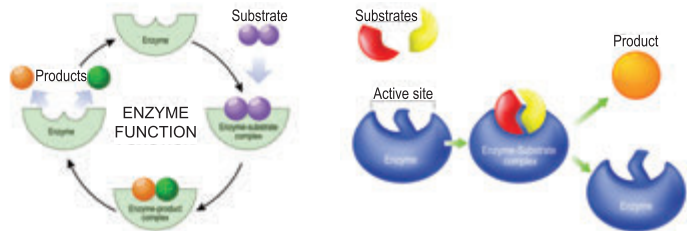
Why does skin wrinkle with age?

Proteins perform different vital functions in the organisms. Their functions are directly related to their shapes. Proteins can be classified depending on their final three-dimensional structure: globular and fibrous proteins.

Globular proteins

In globular proteins, polypeptide chains are folded and coiled tightly to form a spherical shape. Each of them has its specific shape and length of polypeptide chains. Globular proteins are unstable molecules. They are soluble in water and can be easily changed chemically. Their main functions are metabolic. Classes of globular proteins are:

- Enzymes bring reactants together and act as a catalyst. They speed up chemical reactions in the cell.



Enzyme function

- Antibodies are protective proteins. They destroy different antigens protecting the body against disease;

- Transport proteins, such as hemoglobin, carry oxygen in the blood. Channel proteins in plasma membrane allow substances enter and exit the cells;

- Storage proteins, such as myoglobin, store oxygen in muscle;

- Receptor proteins in plasma membranes and inside the cell receive signals from complementary molecules and trigger particular reactions;

- Hormones are regulatory proteins. Insulin regulates the concentration of glucose in the blood;

Fibrous proteins

In fibrous proteins, polypeptide chains are parallel to each other. They are linked together to form long fibres or sheets. Fibrous proteins are insoluble in water and very stable molecules. These proteins provide structure and support for cells. Classes of fibrous proteins are:

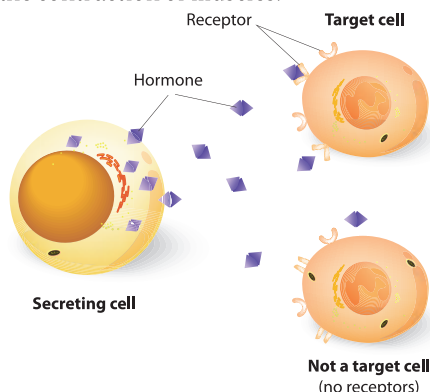
- Structural proteins give support. Keratin is found in hair, skin, nails,



Three polypeptide chains form triple helix structure in collagen

feathers, hooves and horns. Collagen gives flexible strength to tendons, blood vessel walls and skin. Elastin provides strength and elasticity to ligaments;

– Contractile proteins are involved in the movement. Actin and myosin cause the contraction of muscles.



Hormones binding to receptor proteins on cell surface

Activity

a. Compare globular and fibrous proteins. Write four characteristics to each type of protein.

<i>Globular proteins</i>	<i>Fibrous proteins</i>



b. Compete with classmates by finding as much as possible proteins found in human body. Name and label them in the diagram and explain their functions.

Literacy

1. Which levels of organisation of proteins refer to globular proteins?
2. What is the function of triple helix structure in collagen?

Terminology

fibrous - талшықты / волокнистый;
 fragile - нәзік / хрупкое;
 globular - глобулярлы / шаровидный;
 hoof - тұяқ / копыто;
 horn - мүйіз / рог;
 ligament - байлам / связки;

loosen - разрыхлять / жұмсарту;
 scurvy - цинга;
 tendon - сіңір / сухожилия;
 to destroy - жою / уничтожать;
 to remain - қалу / оставаться;
 unstable - тұрақсыз / неустойчивый;
 wrinkle - морщина / әжім.

Facts

Whales' muscles have higher concentration of myoglobin which allows them to remain underwater for long periods of time.



Research time

Deficiency of vitamin C cause scurvy. This disease include the loosening of teeth and internal bleeding. Explore the connection between vitamin C and collagen. Write a report.



Facts

After the age of 20, a body produces less amount of collagen and elastin in the skin year by year. As a result, the skin becomes thinner and more fragile with age.

